Department of Fish and Wildlife
Low Elevation Fisheries
North Central Region

Butte Creek Spring-Run Chinook Salmon Escapement Survey September 2018 – October 2018

By

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Introductions

Butte Creek's 90-mile anadromous portion of the creek extends from the base of the Centerville Head Dam downstream to the confluence of the Sacramento River near Sacramento Slough. Butte Creek supports one of three remaining tributaries that harbor self-sustaining populations of Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*). The other two are nearby Deer and Mill creeks. The 2017 Butte Creek escapement survey was conducted on the approximately 14.5 river miles from Quartz Bowl Pool downstream to Parrot-Phelan Diversion Dam (Appendix A). The survey was divided into six separate reaches which were surveyed once a week from 18 September 2018 through 26 October 2017 (Table 1).

Table 1. Butte Creek Chinook Salmon Escapement Survey Reaches

Reach	Location	Miles
A (sub reaches 1-5)	Quartz Bowl Pool to Whiskey Flat	1.89
B (sub reaches 1-8)	Whiskey Flat to Helltown Bridge	2.17
C (sub reaches 1-12)	Helltown Bridge to Quail Run Bridge	3.46
D (sub reaches 1-8)	Quail Run Bridge to Cable Bridge	1.93
E (sub reaches 1-7)	Cable Bridge to Centerville Covered Bridge	1.71
Covered Bridge to Parrott-Phelan Diversion Dam	Covered Bridge to Parrott-Phelan Diversion Dam	3.41
-	**TOTAL**	**14.57**

The purpose of the survey is to estimate the number of returning spring-run Chinook adults that successfully return to Butte Creek and spawn. The spring-run escapement surveys on Butte Creek have been conducted since 2001 and have been used to compare escapement estimates against the traditional swimming snorkel methodology. Long-term data analysis indicates that snorkel survey methodology likely underestimates the number of adults in Butte Creek when there are large populations.

Pre-spawning mortality surveys allow close monitoring of the population over critical summer holding period. They produce mortality estimates and can be used in conjunction with different survey methods (snorkel, Vaki) to explain the difference in escapement estimates from summer holding to fall spawning. Additionally, without pre-spawning mortality monitoring in place, it is difficult to assess total escapement into Butte Creek versus what proportion of the population successfully make it to spawn.

Materials and Methods

The survey extended from the Quartz Bowl Pool to the Parrott-Phelan Diversion Dam. The approximately 14.5-mile stream section was divided into six reaches. The first five reaches were then subdivided into approximately 0.25-mile segments. The reach described as 'Centerville Covered Bridge to Parrott-Phelan Diversion Dam' was subdivided into three segments. Each reach was surveyed once per week. Department personnel walked downstream, covering both sides of the creek and any side channels. All Chinook salmon carcasses encountered while

conducting the escapement survey were collected and evaluated for decomposition status and the presence of a coded-wire tag (CWT). Decomposition status was determined by the coloration of the fish's eyes and gills. Carcasses containing either one clear eye or pink coloration of the gills were determined to be 'fresh' fish. Carcasses failing to contain one of the above-mentioned requirements were determined to be 'non-fresh.' Along with the determination of decomposition, both fresh and non-fresh carcasses were inspected for the presence of a CWT.

All fresh fish were identified to sex and measured to the nearest millimeter (mm) fork length. Carcasses with a fork length ≥ 600mm were classified as adult fish; fork lengths ≤600mm were classified as grilse, or young adult fish. Fresh carcasses possessing an adipose fin were processed and tagged with a unique numbered metal disc attached to the maxilla. Following the attachment of a metal disc tag, carcasses were returned to flowing water to simulate natural downstream dispersal. Decomposing non-fresh carcasses were chopped in half to prevent recounting. Non-fresh previously marked carcasses were either chopped in half or left in place and were recorded as a recovery. Fresh adult carcass data was used in the Cormack Jolly-Seber Superpopulation model to estimate population size.

Tissue samples were taken from the first 10 fresh carcasses encountered in each reach. Clean scissors were used to cut a small piece (10-mm sq.) of tissue from the caudal fin. If all fins were eroded or decayed, a small piece of skin was taken. Each sample was placed in a pre-labeled vial containing tris-buffer and placed into a container. Between each sample, scissors were rinsed in fresh water to prevent cross contamination.
Scale samples were taken from fresh carcasses with firm skin and from the side of the carcass, below the posterior insertion point of the dorsal fin and slightly above the lateral line. The scales were collected from an area that is approximately one-inch square.

Flow data were obtained for the survey period from the Department of Water Resources California Data Exchange Center at Station Id BCK (Butte Creek near Chico) gauge. Water temperatures were obtained from Onset Hobo Data Loggers launched at Quartz Bowl Pool in Upper Butte Creek.

Escapement estimates were calculated using the Cormack-Jolly-Seber (CJS) mark-recapture model for open populations (Bergman, et al. 2012) with R statistical software, version 3.3.2 (www.r-project.org).

Results

Survey Periods

Sampling occurred every Tuesday and Thursday during each sampling date range. There were no survey days that were cancelled due to inclement weather or high-water flows. Each fish encountered was processed because low numbers of fish observed during the 2018 snorkel survey. The survey was conducted over 6 survey periods from September 18, 2018 to October 25, 2018 (Table 2).

Table 2. Butte Creek spring-run survey sampling periods for 2018.

Survey Period	Date Range
1	Sept 18 - 20
2	Sept 25 - 27
3	Oct 02 - 04
4	Oct 09 - 11
5	Oct 16 - 18
6	Oct 23 - 26

Final Carcass Count

A total of 992 carcasses was collected and processed during the 6-week survey period. The maximum number of carcasses observed in a single survey period was 498 during survey period 43(Oct. 02-04) (Table 3, Figure 1).

Table 3. Total salmon carcasses processed and observed from September 18 to October 25, 2018.

Survey Period	Date Range	Total Carcasses
1	Sept 18 - Sept 20	3
2	Sept 25 - Sept 27	22
3	Oct 02 - Oct 04	498
4	Oct 09 - Oct 11	322
5	Oct 16 - Oct 18	103
6	Oct 23 - Nov 25	44
	Total	**992**

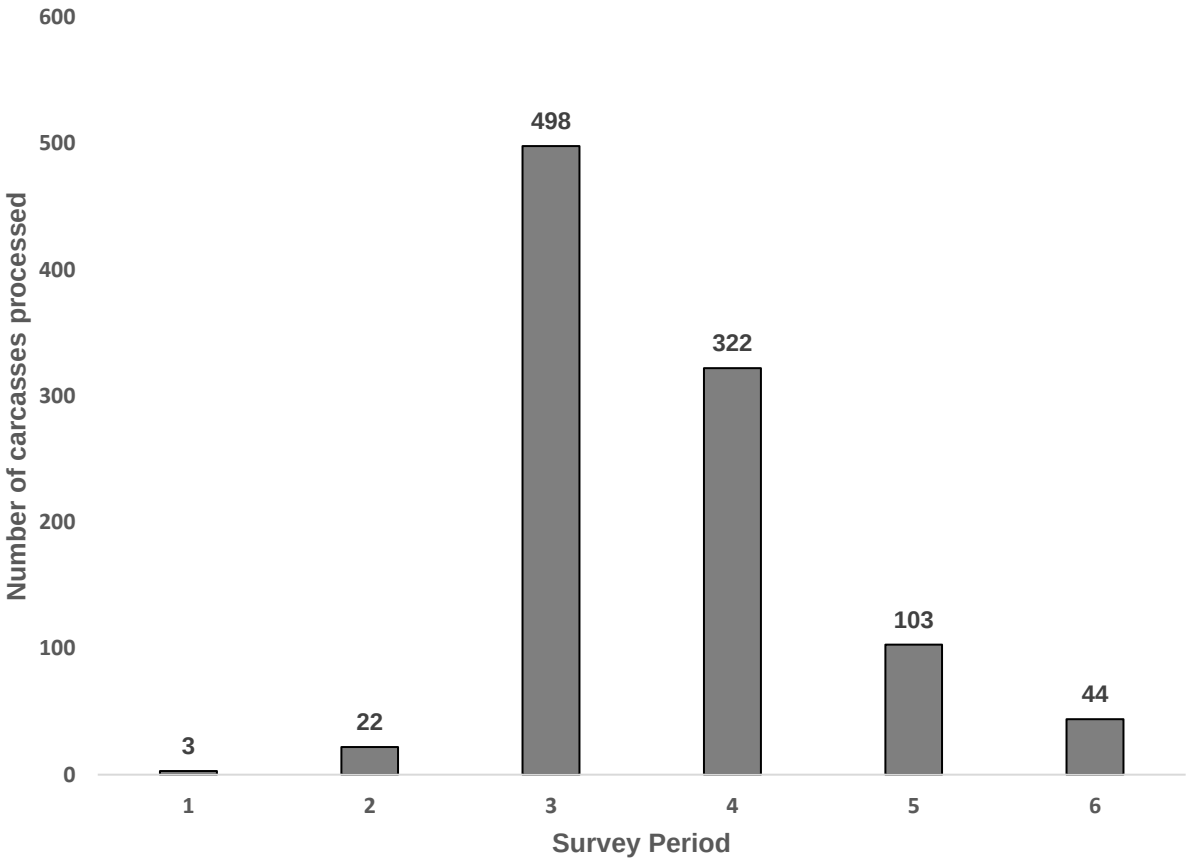

Figure 1. Number and temporal distribution of carcasses processed during the 2018 Butte Creek salmon escapement survey.

Fresh carcasses were processed every survey period expect for period 6. All carcasses encountered during survey period 6 were chopped and no tags were applied to any fish. The greatest number of fresh carcasses occurred during survey period 3 when 188 were processed. Most carcasses that were handled were non-fresh (68%, *n* =675); 32% (*n* = 317) were recorded as fresh (Table 4 and Figure 2).

Table 4. Summary of salmon carcass freshness from September 18, 2018 to October 25, 2018.

Survey Period	Dates	Fresh	Non-Fresh	Total	%
1	Sept. 18 to Sept. 20	3	0	3	1%
2	Sept. 25 to Sept. 27	19	3	22	2%
3	Oct. 02 to Oct. 04	188	310	498	50%
4	Oct. 09 to Oct. 11	87	235	322	33%
5	Oct. 16 to Oct. 18	20	83	103	10%
6	Oct. 23 to Oct. 25	-	44	44	4%

Survey Period	Dates	Fresh	Non-Fresh	Total	%
	Total	**317**	**675**	**992**	
	%	32	68		

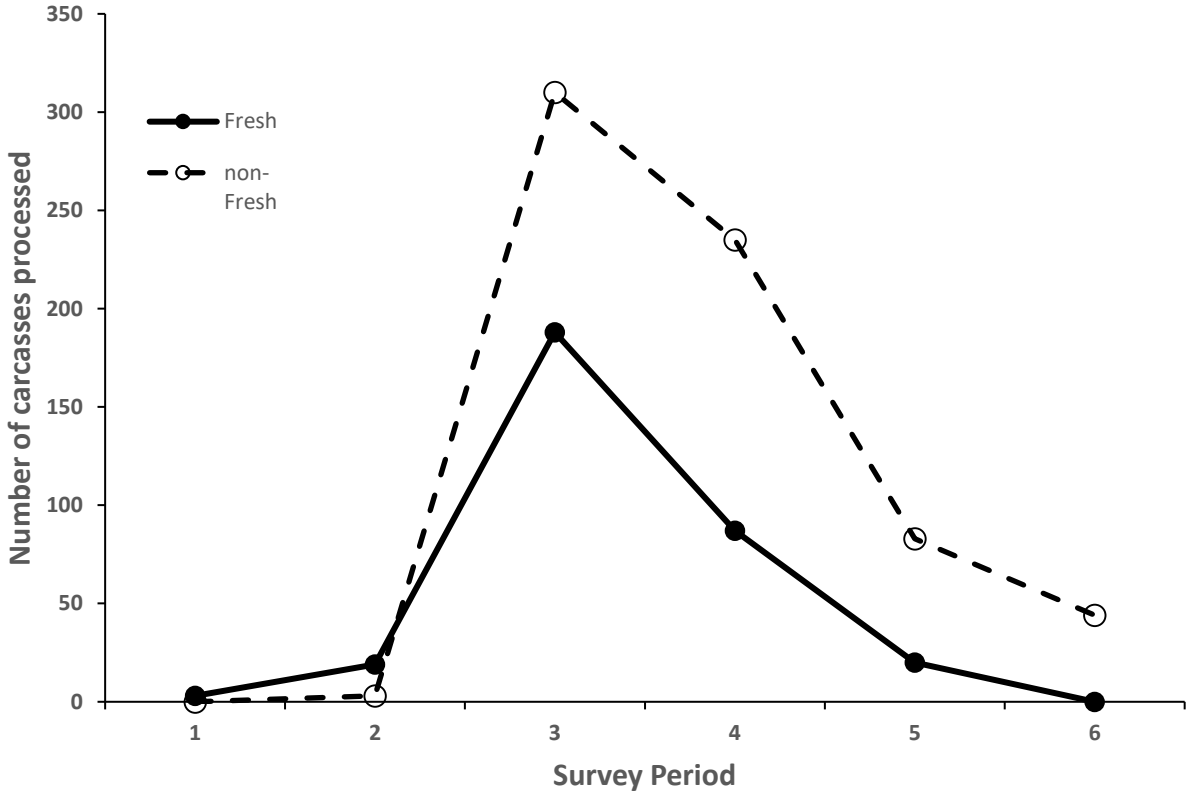

Figure 2. Temporal distribution of salmon carcass freshness from September 18 to October 25, 2018.

Spatial Distribution

Most carcasses observed occurred in sections C (43%, *n*=417). The fewest number of carcasses observed was in the downstream section of Reach E (7%, *n*=66). Eighty-three percent of carcasses were processed between survey periods 3and 4 (Oct. 2 to Oct. 11) (Table 5). Spawning percentage per reach was fairly consistent in reaches A, B, D and E, with 14.5%, 11.3%, 20.5%, and 8.4%, respectively.. However, heavier usage was observed from Helltown Bridge downstream to Quail Run Bridge (49%). The CJS population estimate, after applying encountered carcasses to weekly intervals, estimated that 2,362 fish survived to spawn. Reach C (n = 1063) had the most spawning activity followed by Reach D (n = 486) (Figure 3).

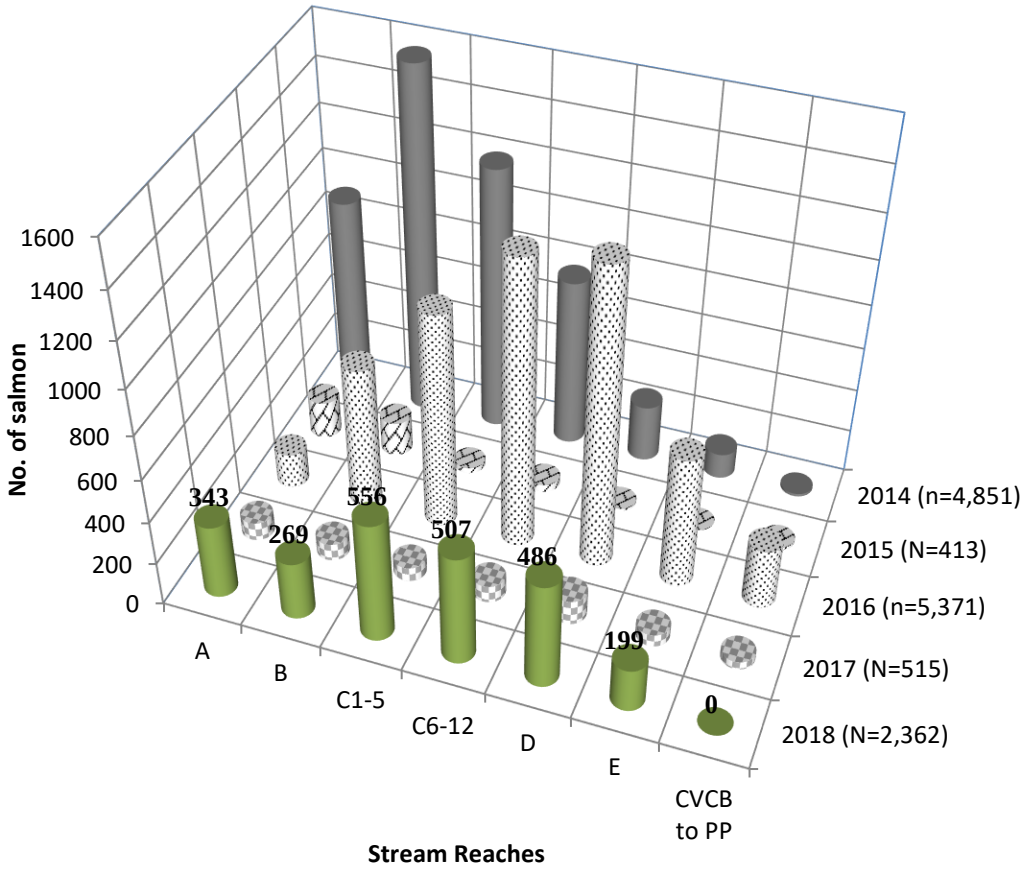

Figure 3. Spawning distribution by reach on Butte Creek from September 18 to October 25, 2018.

Table 5. Total salmon carcasses processed by survey section from September 18 to October 25, 2018.

SURVEY PERIOD	DATES	A	B	C	D	E	TOTALS	%
1	**SEPT. 18 TO SEPT. 20**	**2**	**1**				**3**	**1%**
2	**SEPT. 25 TO SEPT. 27**	**6**	**4**	**8**	**4**		**22**	**2%**
3	**OCT. 02 TO OCT. 04**	**44**	**59**	**230**	**118**	**47**	**498**	**50%**
4	**OCT. 09 TO OCT. 11**	**49**	**85**	**119**	**53**	**16**	**322**	**33%**
5	**OCT. 16 TO OCT 18**	**27**	**16**	**48**	**9**	**3**	**103**	**10%**
6	**OCT. 23 TO OCT. 25**	**15**	**17**	**12**			**44**	**4%**
	TOTALS	143	182	417	184	66	992	100%
	%	**14%**	**18%**	**42%**	**19%**	**7%**	100%	

Length Composition

A total of 317 carcasses was processed for FL and sex (Figure 4). Male carcass minimum and maximum FL were 45.5cm and 95cm, respectively with a mean of 75.7cm (Figure 5). Minimum and maximum FL for female carcasses were 56cm and 89.1 cm respectively with a mean of 70.6 cm (Figure 6).

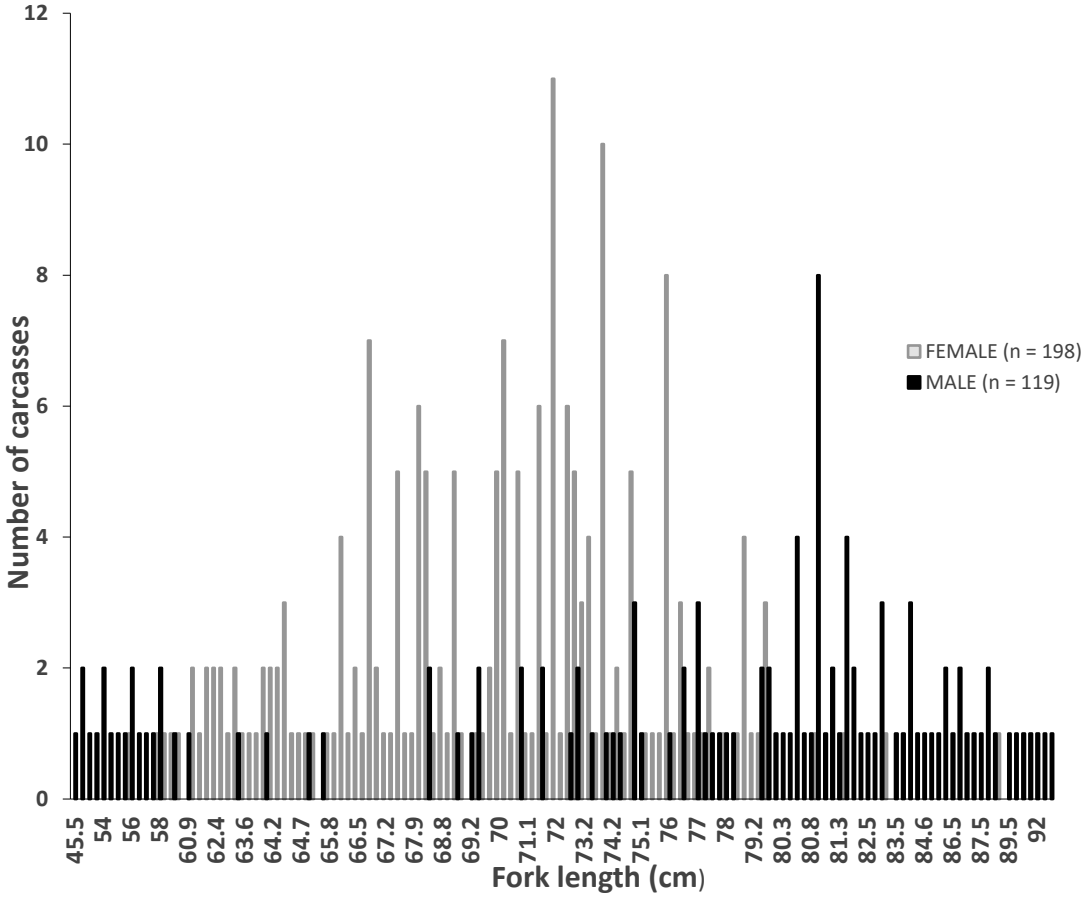

Figure 4. Salmon carcass fork length frequency distribution of 317 carcasses from September 18 to October 25, 2018.

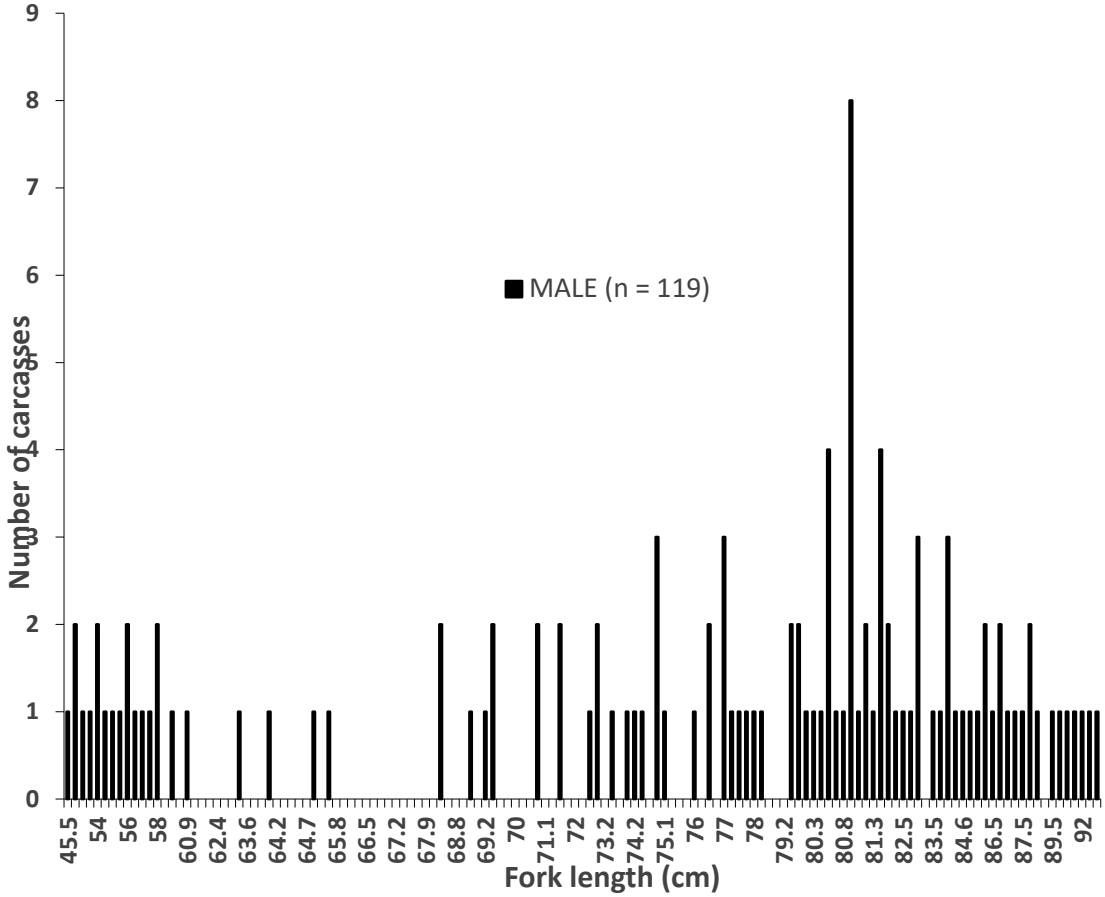

Figure 5. Length frequency distribution of 119 male carcasses from September 18 to October 25, 2018.

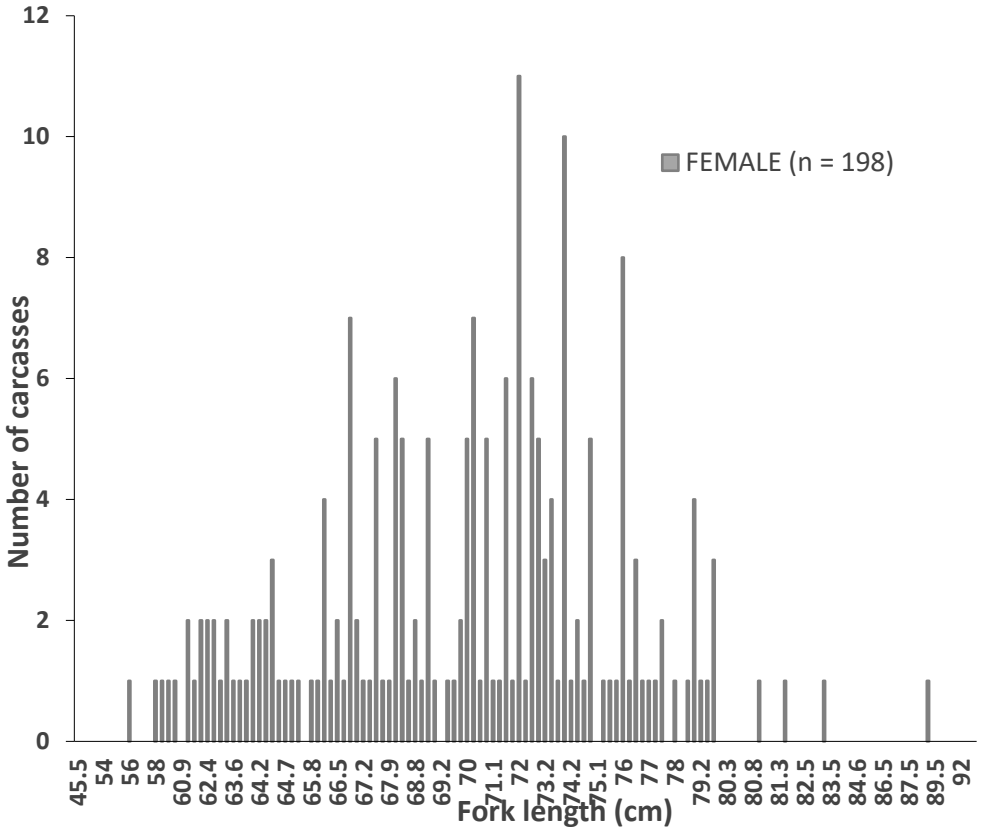

Figure 6. Length frequency distribution of 198 female carcasses from September 18 to October 25, 2018.

Sex Composition

A total of 992 carcasses was handled during the carcass survey of which 317 were processed for length and sex. Females consisted of 62% (n =198) and 38% (n = 119) were males (Figure 7). There were 675 carcasses that were not recorded for sex or length and were chopped in half and recorded as chops on first capture (Table 6).

Table 6. Total salmon carcasses processed from September 18 to October 25, 2018.

Survey week	Date	Female	Male	Not Recorded	Total
1	Sept. 18 to Sept. 20	3	0	0	3
2	Sept. 25 to Sept. 27	10	9	3	22
3	Oct. 02 to Oct. 04	106	82	310	498
4	Oct. 09 to Oct. 11	64	23	235	322
5	Oct. 16 to Oct 18	15	5	83	103
6	Oct. 23 to Oct. 25	0	0	44	44
	TOTALS	**198**	**119**	**675**	**992**
		62%	**38%**		

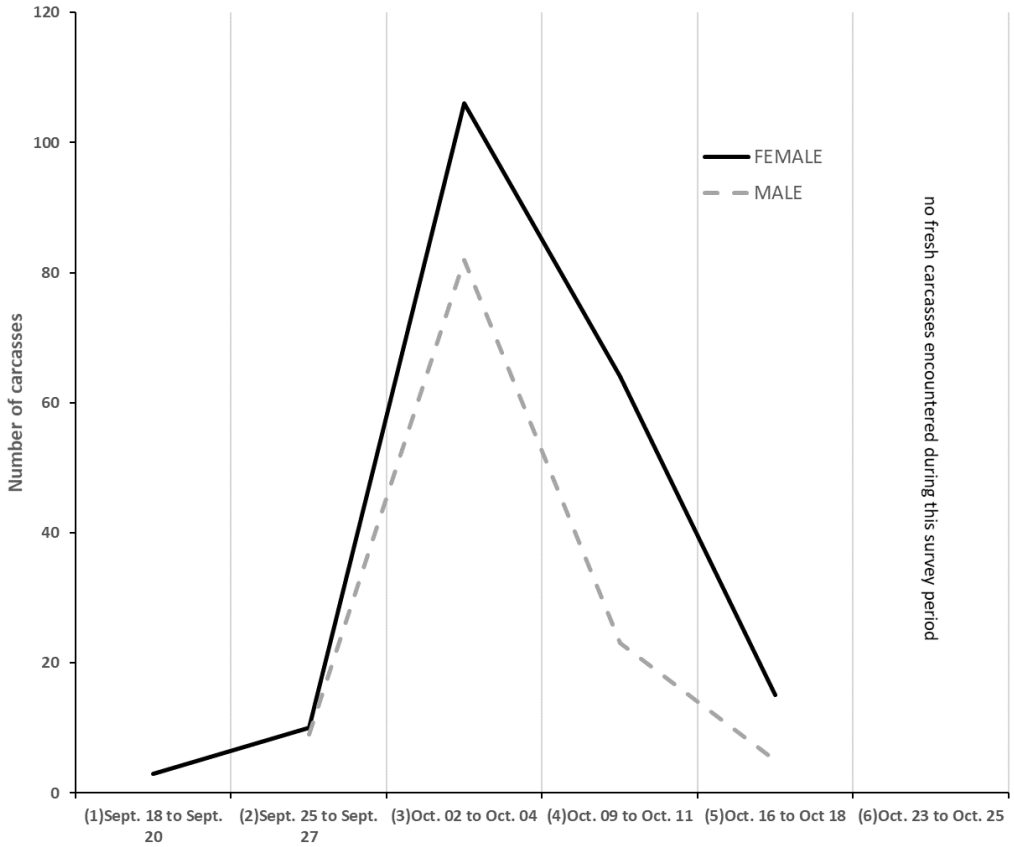

Figure 7. Total carcasses processed and identified by sex for mark re-capture from September 18 to October 25, 2018.

Population Estimate

The CJS population model was used to estimate the 2018 SRCS escapement (Cormack 1964; Bergman et al. 2012). Three hundred seventeen salmon carcasses were disk-tagged for the mark-recapture study, and 88 disk-tagged carcasses were recaptured which is a recovery rate of 28%. The SRCS escapement estimate for Butte Creek is 2,362. The bootstrap estimate of the standard error of estimated total escapement is 5491.646 (n=5,000 bootstraps). With 90% bootstrap confidence intervals, total escapement is estimated to range between 2,129 and 2,807.

Environmental Conditions

Butte Creek water temperature was only recorded for 10 days before the Onset Hobo temperature logger failed. It recorded water temperatures that are commensurate with typical water temperatures for that time of year. As seen in past reports, (Garman, 2017) a rain event in early October increases flows and water temperatures increase, followed by a gradual decrease in temperatures due to ambient environmental conditions associated with autumnal seasonal changes. The maximum and minimum recorded water temperatures at Quartz Bowl Pool were 13.3°C on September 24, and 12.6°C on September 18, respectively, with an average temperature of 13.0°C (Figure 6). Butte Creek flows remained fairly constant throughout the spawning period with the exception of a rain event from October 2-4, 2018 which increased

flows to a maximum of 130 cubic feet per second (cfs). Minimum flows were 77 cfs on September 28, with an average flow of 90 cfs (Figure 8).

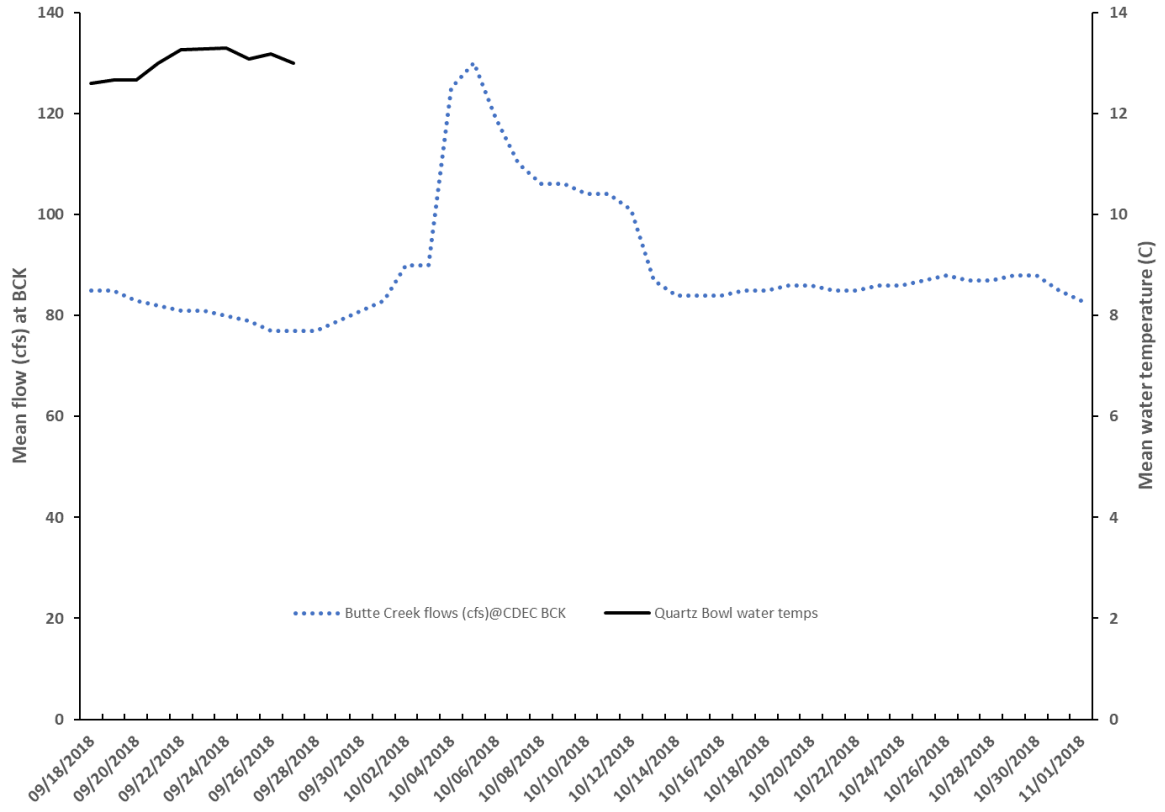

Figure 8. Mean daily river flows and mean daily water temperatures observed during the 2018 Butte Creek carcass survey.

Conclusions

For the second consecutive year, environmental conditions likely influenced the final escapement estimate of spring-run Chinook salmon in Butte Creek for the 2018 spawning season. Rain occurred on 2 October and continued until 4 October 2018 increasing flows from a base level of approximately 77 cfs to 130 cfs. Typically, a one-day rain event occurs, elevates flows and the creek quickly returns to base flows. This survey period had a three-day rain event which resulted in a more protracted elevated flow regime and the creek did not come back to base flows for over a week. 'Wash out' events, defined as periods when the survey could not be conducted because of high flow and/or visibility, do not typically occur during the SRCS spawning season on Butte Creek. During wash out events, carcasses can be dislodged from their resting state and become dispersed into places outside the typical survey resulting in low recovery rates of marked fish and low numbers of overall carcass detectability during the survey. Based on past CWT data, Butte Creek returning adult populations are predominately 3-year old fish. The 2018 estimate of **2,362** results in a 5.7 cohort replacement rate of the 2015 Brood Year. Since the inception of the mark re-capture survey in 2001, the minimum and maximum escapement estimates are 413 and 18,312, respectively. The average number of returning adults is 7,874 (Figure 9).

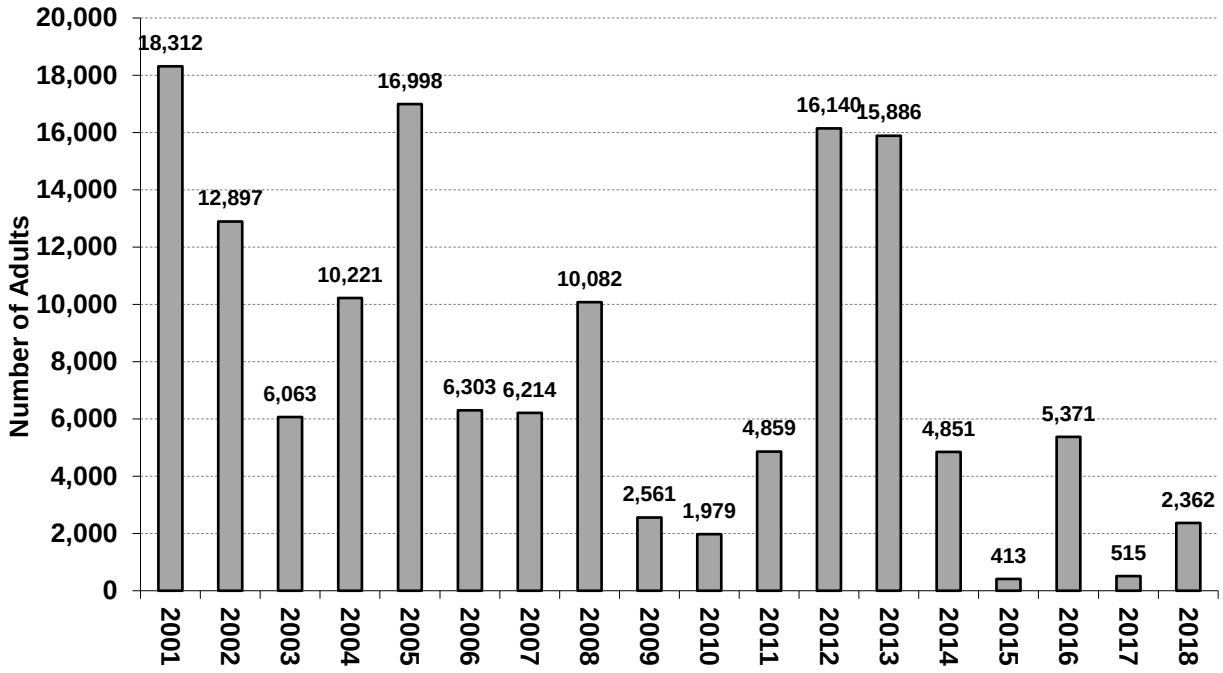

Figure 9. Number of returning adults into Butte Creek from 2001-2018.

Acknowledgements

Special thanks to the California Department of Fish and Wildlife's Fisheries Restoration Grant Program for securing funding to continue to monitor this population of spring-run Chinook salmon. Additionally, we acknowledge the various field crew members that participated during the 2018 season including: Christian Moala, Brad Underwood, Donovan Whitworth, and Daniel Thompson.

Literature Cited

Bergman, J. M., R. M. Nielson, and A. Low. 2012. Central Valley in-river Chinook salmon escapement monitoring plan. Fisheries Branch Administrative Report Number: 2012-1. California Department of Fish and Game. Sacramento, CA.

Garman, C.E. 2017. Butte Creek Spring-Run Chinook Salmon Escapement Survey September 2017 – October 2017, pp. 12